



MSI-ix/Rx MSI-ix/Tx


Modulares Sicherheits-Interface
Anschluß- und Betriebsanleitung

Modular Safety Interface
Connection and Operating Instructions



Notes on connection and operating instructions

These instructions contain information on the efficiency in the use of MSI Safety Interfaces in accordance with their intended applications. These instructions constitute a part of the scope of delivery.

Warning and safety notes are indicated by the symbol .

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1 System Overview and Range of Applications

1.1 General Information

The Modular Safety Interface (MSI) serves as a link between one or more active optoelectronic protective devices (AOPD), Type 2, Type 3 or Type 4, and the machine controls. All MSI safety components include restart interlock and external device monitoring functions that can be activated and deactivated. They are also equipped with a series of status outputs and LED displays as well as a diagnosis interface to a PC.

In addition, MSI-ix/Rx and MSI-ix/Tx offer a selection between guard only operation and cyclical operation.

During cyclical operation, the machine is controlled by means of the interruption and subsequent release of the protected field. Special safety regulations for cyclical operation are described in Section 2.4 below.

All MSI safety components are available with either relay outputs or with safety-oriented pnp semiconductor outputs. The MSI x-variants allow the additional connection of safety interlocks or emergency-stop push buttons regarding category 4.

1.2 Approvals

Europe	North America
Type Examination in accordance with EN IEC 61496, Section 1 B I A Berufsgenossenschaftliches Institut für Arbeitssicherheit (Trade Association Institute for Industrial Safety) 53757 Sankt Augustin Germany	UL and C(UL) Approval pending

1.3 Terminology

AOPD	Active Optoelectronic Protective Device
Clear	Clearance of Cycles, Test
Diagn.	Diagnosis Function
EDM	External Device Monitoring
ESPE	Electro-sensitive Protecting Equipment
Fault	Relay Fault
Locked	Start/Restart Interlock active
N.C.	Normal Closed Contact
N.O.	Normal Open Contact
OSSD	Output Signal Switching Device
Reset	Start/Restart Interlock Initiator
RS 232	Interface RS 232

S1 - S4	Safety input 1 - 4
S1 & S2 S3 & S4	Indication protected fields free/interrupted
Select	Selection of Cyclical Operation
SSD	Secondary Switching Device (switches to ON state when the MSI is ready for operation)
Test	Test Signal Outputs
T1, T2	Test signal output 1, 2
Warn. (Rx Module)	Warning (preset number of switching operations exceeded)

1.4 Nomenclature MSI-ix/Rx and MSI-ix/Tx

MSI	Modular Safety Interface
i	with modes of operation Guard only, Single break or Double break
x	<p>extended functions</p> <p>The extended version offers the following standard functions for either 2 AOPDs, Type 4, or up to 4 AOPDs, Type 2:</p> <ul style="list-style-type: none"> – Restart interlock – External device monitoring – Diagnosis function <p>and the following special functions for 1 AOPD Type 4 or 1 AOPD Type 2:</p> <ul style="list-style-type: none"> – Cyclical operation – Displays and status outputs for guard and cyclical operation
/Rx	<p>Relay output with extended functions:</p> <ul style="list-style-type: none"> – two normal open safety contacts, OSSD 1 and OSSD 2 – one normal closed safety contact OSSD 3 – one normal open contact "MSI readiness" SSD <p>Additional special function:</p> <ul style="list-style-type: none"> – Relay operation monitoring with pre-failure message
/Tx	<p>Transistor output with extended functions:</p> <ul style="list-style-type: none"> – two safety-oriented pnp semiconductor outputs, OSSD 1 and OSSD 2 – one normal open contact "MSI readiness" SSD

2 Safety Precautions



2.1 General Hazards Caused by Non-Observance of Safety Precautions

Leuze lumiflex products are developed and produced with careful attention to recognized codes of engineering practice. However, the protective function of the equipment can be impaired if the devices are not used for their

intended purpose or if they are used improperly. Such instances can jeopardize the health and lives of the personnel operating the machinery.

2.2 Operating Conditions and Proper Use

The relevant regulations for machine safety apply for the use of the Modular Safety Interface. The responsible local authorities (e.g. the German Berufsgenossenschaft [trade association] or OSHA) are available to answer questions related to safety issues. In general, the following conditions for use must be complied with:

- The electrical connection is to be performed only by experienced, expert personnel. Familiarity with the safety precautions in this operating manual constitutes part of this expert knowledge.
- Depending on the external cabling, the switch outputs can have dangerously high voltages. Before any work is done on the MSI safety interface, these outputs as well as the supply voltage must be switched off and safeguarded against being switched on again.
- The MSI is designed to be installed in an electronics cabinet or in a protective housing with an enclosure rating of at least IP 54.

- The supply voltage of 24 V DC \pm 20% must exhibit a safe mains separation and be able to bridge brief power outages of 20 ms.
- The MSI fulfills the requirements of Safety Category 4 in accordance with EN 954-1. However, if an AOPD from a lower safety category is connected, the overall category for that path of the controls cannot be higher than that of the connected AOPD.
- As a rule, at least two switch contacts or safety-related pnp-semiconductor outputs must be connected into the switch-off circuit of the machine. In order to prevent the relay switch contacts from welding together, they must be externally fused as specified in the Technical Data, Chapter 6.
- It is not allowed to use status outputs to switch safety-related signals.
- Cross circuits between S1 and S2 respectively S3 and S4 are detected by the MSI safety component only if the two time-displaced test signal outputs T1 and T2 are used for the connected AOPD(s) with relay outputs.

Type 4 AOPDs with safety-related semiconductor outputs and their own cross circuit monitoring can be connected directly to S1 and S2 or S3 and S4.

- The "Reset" button for resuming operation following a restart interlock must be placed in a location from which the entire danger area can be clearly watched.
- The safety distance between the AOPD and the danger point must be maintained. It is calculated according to the formulas in the specific machine-related C-Standards or in the general B1 Standard EN 999. The

2.3 Additional advice as to connect EMERGENCY STOP buttons

- It must be secured that the EMERGENCY STOP function is always and immediate effective. EMERGENCY STOP buttons must not be connected at sensor inputs which provide for muting or cycling control functions! In Chapter 5, Connection examples, there is a particular example illustrating the connection of an EMERGENCY STOP button.

2.4 Additional Safety Precautions for the Special Function "Cyclical Control"

- Special safety precautions must be followed for controlling protective devices. For example, it must be impossible to step behind the protective device on the side facing the danger point. Stepping into or through the protected field would automatically cause the dangerous movement to be enabled!
- More specific regulations can be found in the European Standard EN 292-2 in Section 4.2.2.5, Control guards.

response time of the MSI (Chapter 6, Technical Data), the response time of the protective device, and the stopping time of the machine must all be taken into consideration when calculating the safety distance.

- AOPDs are not suitable in applications where a danger of throwing out pieces or splashing out hot or dangerous liquids exists. Also they are not suitable for machines with extended stopping times. For these or similar applications Leuze lumiflex offers interlocking devices (safety switches) with or without guard locking.
- When a two-channel Section Emergency Stop button is connected, MSI is able to realize a Section Emergency Stop function. Section Emergency Stop buttons connected to the MSI only affect the safety circuit that is assigned to the AOPD. For this reason, it is referred to as an Section Emergency Stop. The limited area of effect of the button must be identified for the operating staff in a manner that is clearly visible.

In addition, the European Standard for Hydraulic Presses EN 693 contains restrictions on the minimum height of the press table and on the maximum dimensions of the access (window) opening. If these stipulations cannot be complied with, additional measures must be taken to reliably monitor the interior of the machine.

3 System Configuration and Functions

3.1 System Configuration

Two microprocessors handle the redundant processing of the signal sequences within the intelligent Modular Safety Interface MSI. The results of the two processors are continuously compared. If any deviations are found, the safety-related outputs are immediately switched off and the LED indicating an MSI failure lights up.

Sensor signals at inputs S1 and S2 as well as S3 and S4 are checked. Depending on which of the functions (as described below) are selected, when the protected fields of all connected AOPDs are free the MSI outputs switch automatically to the ON state (without restart interlock) or remain in the OFF state until the reset button has been pressed and released (with restart interlock = standard operating mode).

MSI-ix is available with two output options: the MSI-ix/Rx has two positive-guided normal open contacts and one

positive-guided normal closed contact, while the MSI-ix/Tx has two safety-oriented pnp semiconductor outputs.

Furthermore, both versions offer an additional normal open contact SSD (Secondary Switching Device) which assumes the ON state when the MSI-ix is ready for operation.



The SSD contact does not open when a protected field is interrupted! It may be used to switch off a second path (e.g. the motor power supply) if the MSI Safety Interface falls into an error condition.

The MSI safety interface comes in a 35 mm-wide slide-in housing that holds the MSI-ix module and the /Rx or /Tx output module. It is suitable for mounting on a grounded 35 mm standard rail.

3.2 DIP Switch Settings

3.2.1 DIP Switch Settings for the MSI-ix Module

Cut off the voltage supply to the interface (see safety precautions in Section 2.2) loosen the subassembly with

the imprint MSI-ix and pull this module partly out of the housing before resetting the DIP switches:



Functions **only** in conjunction with external wiring, see Section 3.3:

DIP Switch	DS4	DS3	DS2	DS1
Function	None	Locking	External Device Monitoring	Cycle Time-limit
Up		restart interlock only	Static•- none**	30 min.
Down		start/restart interlock* - none**	dynamic	30 sec.

Factory setting: all switches down

* See 3.3.1.1 – 3.3.1.3

** See 3.3.1.4

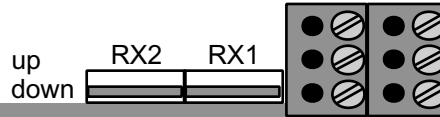
• See 3.3.1.2

•• See 3.3.1.3 – 3.3.1.5

3.2.2 DIP Switch Settings for the Rx Output

Cut off the voltage supply to the interface (see safety precautions in Section 2.2) loosen the subassembly Rx

Output and pull it partly out of the housing before resetting the DIP switches:



DIP Switches	RX2	RX1
Function	Warning: 1,000,000 operations performed	
Up		
Down	x	x

DIP Switches	RX2	RX1
Function	Warning: 500,000 operations performed	
Up	x	
Down		x

DIP Switches	RX2	RX1
Function	Warning: 200,000 operations performed	
Up		x
Down	x	

DIP Switches	RX2	RX1
Function	Warning: 100,000 operations performed	
Up	x	x
Down		

Factory setting: switches down (Warning after 1,000,000 operations)
 Recommended setting: See Section 3.3.5

3.3 Operating Modes and Functions

- MSI-ix/Rx and MSI-ix/Tx permit the following modes of operation and functions:
- Guard function offers the possibility of combining start/restart interlock and external device monitoring (see below).
- Five operating modes can be selected by means of external wiring and the DIP switches DS2 and DS3 on the MSI-ix module.
- Cyclical operation as single break or double break operation with guard function. In cyclical operation, the

AOPD connected at S1 controls the process. Special safety precautions are required as described in Section 2.4, Safety Precautions. Start/restart interlock is a necessary precondition for cyclical operation. Whenever cyclical operation is selected, terminal 13 must be connected to 24 V DC by way of a reset button! See more in Section 3.3.3.

A three-point keyed switch is used to select among the operating modes. Changes at this keyed switch may only be made by trained specialists. If just one of the available operating modes is going to be required, we recommend permanently wiring this mode using a bridge.

3.3.1 Operating Modes Interlocking Functions and External Device Monitoring

The following 5 combinations can be selected by externally wiring the MSI Safety interface and/or by changing

the settings of the DIP switches DS2 and DS3 in the MSI Module:

OPERATING MODES			
Section	Type of Locking	Type of External Device Monitoring	Cyclical Function
3.3.1.1	With start/restart interlock	with dynamic ext. device monitoring	possible
3.3.1.2	With start/restart interlock	with static ext. device monitoring	possible
3.3.1.3	With start/restart interlock	without external device monitoring	possible
3.3.1.4	Without start/restart interlock	without external device monitoring	not possible
3.3.1.5	With start/without restart interlock	without external device monitoring	not possible



The MSI safety interface is factory-set for the operating mode "with start/restart interlock and dynamic external device monitoring". If this setting is changed, these functions (i.e. the appropriate safety level) must be guaranteed by other means.

- Types of interlocking functions
The „start interlock function“ ensures that when the system is switched on or when the supply voltage returns, even if the protected field is free the safety-related output contacts or semiconductor outputs

(OSSDs) do not automatically go into ON state, but rather wait until the reset button has been pressed and let go.

The „restart interlock function“ prevents the OSSDs from automatically entering the ON state when the protected fields of one or more of the connected AOPDs are released again after an interruption. Here as well, the reset button must be pressed and let go to initiate the system.

Cyclical operation and muting are not possible if there is no locking (and hence no reset button) since the start button is also used to perform the function of the cyclical and muting reset.

- Types of External Device Monitoring

The function „dynamic external device monitoring“ monitors the relays connected downstream from the MSI safety interface. Each time before the OSSDs switch to the ON state, a check is made of whether the subsequent circuit elements have closed and reopened. If they have not, the OSSDs of the MSI safety interface remain in the OFF state.

If the function „static external device monitoring“ is selected, a check is merely made of whether the subsequent circuit elements are in an open state. If they are, the start/restart interlock can be initiated.

3.3.1.1 Operating Mode: With Start/Restart Interlock – With Dynamic External Device Monitoring

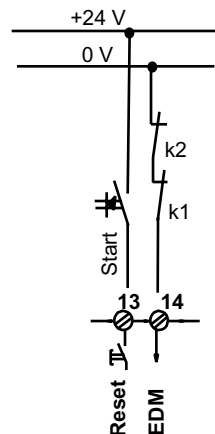
External wiring requirements:

Terminal 13 connected to +24 V
"Reset"

Terminal 14 connected to 0 V by way of feedback contacts of the positive-guided downstream relay

Required DIP switch settings in the MSI module (Section 3.2):

DS3 down DS2 down (factory setting at delivery)



Start/restart interlock is no longer active when the protected fields of all connected AOPDs are free, the downstream relays have returned to their original state, and the reset button is pressed and released.

3.3.1.2 Operating Mode: With Start/Restart Interlock – With Static External Device Monitoring

External wiring requirements:

- Terminal 13 connected to +24 V "Reset" by way of a start button
- Terminal 14 connected to 0 V by way of feedback contacts of the positive-guided downstream relay

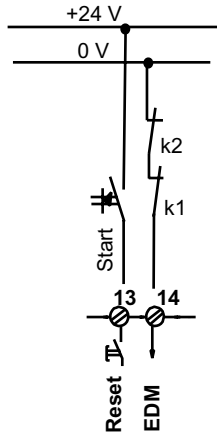
Required DIP switch settings in the MSI module (Section 3.2):

DS3 down DS 2 up

In this operating mode, if the protected fields are free, a check is merely made of whether the downstream circuit elements have returned to their original state. If so, a release is issued by pressing and letting go of the reset button.



The dynamic monitoring of the downstream relays, which may be required in order to maintain the safety category, must be performed by other means.



3.3.1.3 Operating Mode: With Start/Restart Interlock – Without External Device Monitoring

External wiring requirements:

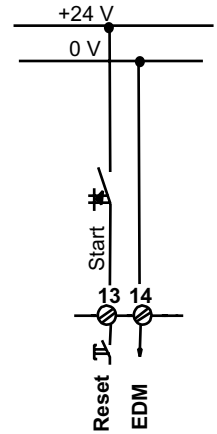
- Terminal 13 connected to +24 V by "Reset" way of a start button
- Terminal 14 connected to 0 V "EDM"

Required DIP switch settings in the MSI module (Section 3.2):

DS3 down DS2 up



The dynamic monitoring of the downstream relays, which may be required in order to maintain the safety category, must be performed by other means.



3.3.1.4 Operating Mode: Without Start/Restart Interlock – Without External Device Monitoring

Cyclical operation not possible in this operating mode!

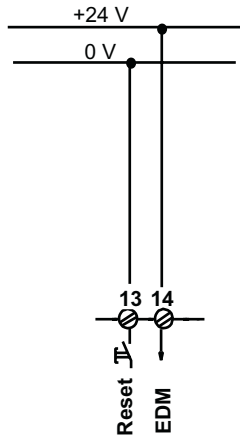
External wiring requirements:

Terminal 13 connected to 0 V
"Reset"

Terminal 14 connected to +24 V
"EDM"

Required DIP switch settings in the MSI module (Section 3.2):

DS3 down DS2 up



After the supply voltage is applied, the OSSDs immediately go into the ON state if all of the protected fields of the connected AOPDs are free.

In this case, the start/restart interlock function and the dynamic monitoring of the downstream relays, which may be required in order to maintain the safety category, must be performed by other means.

3.3.1.5 Operating Mode: With Start/Without Restart Interlock – Without External Device Monitoring

Cyclical operation is not possible in this operating mode!

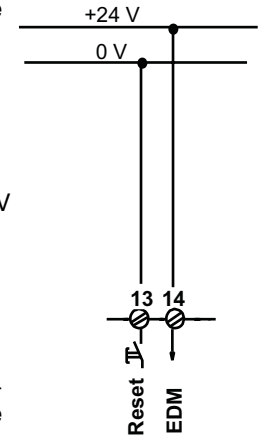
External wiring requirements:

Terminal 13 connected to 0 V
"Reset"

Terminal 14 connected to +24 V
"EDM"

Required DIP switch settings in the MSI module (Section 3.2):

DS3 up DS2 up



When the protected fields of all connected AOPDs are initially free, the OSSDs first enter the ON state when the protected field of the AOPD connected at S1 (for Type 4: S1 and S2) is interrupted and released. Only then do the rest of the connected AOPDs respond to the interruption and release of their own protected fields by switching the OSSDs directly to the OFF and ON states.

In this case, the restart interlock function and the dynamic monitoring of the downstream circuit elements, which may be required in order to maintain the safety category, must be performed by other means.

3.3.2 Guard Operation, Test Function

If the protected fields are free, it is possible to simulate an interruption of the protected field of the AOPD connected at S1 (for Type 4: S1 and S2) by way of the "Clear" input. During this procedure, the safety-related outputs will switch to the OFF state. Test is activated if 24 V at Pin 20 is disconnected via a normal closed contact.

3.3.3 Cyclical Operation as Single Break or Double Break with Guard Function

Special safety precautions must be taken when the protective device is used to control the machine. These are described in Safety Precautions, Section 2.4.

At terminal 21 "Select" you can choose the operating modes "guard only", "single break operation" or "double break operation". Start/restart interlock is a necessary precondition for cyclical operation, which means that terminal 13 must always be connected to +24 V by way of the start button. There are some options available with regard to external device monitoring. It can be performed either dynamically or statically, or it can be dispensed with completely if the requirements for maintaining the safety category are fulfilled by other means.

Cyclical Operation:

The start interlock ensures that the OSSDs remain in the OFF state after the supply voltage has been switched on. The display "restart interlock" (symbol: lock) is constantly lit.

The following applies for single break operation:

When the start button is pressed, the readiness for cyclical operation is achieved, and the display "restart interlock" emits a single blink which is repeated in short

intervals. The controls remain in this condition and wait for a controlling interruption of the protected field for at least 300 ms.

If operating mode "Start Interlock only" (as in 3.2.1.5) is selected, the "Clear" input also serves as the remote start for the AOPD connected at S1 (for Type 4: at S1 and S2). In this case, it is no longer necessary to initiate the first start by interruption the protected field.

intervals. The controls remain in this condition and wait for a controlling interruption of the protected field for at least 300 ms.

The following applies for double break operation:

When the start button is pressed, the readiness for cyclical operation is achieved, and the display "restart interlock" emits a double blink which is repeated in short intervals. After the first interruption for at least 300 ms, the display emits a repeated single blink. The controls remain in this condition and wait for the second controlling interruption of the protected field.

Cycling Operation Time monitoring

A time monitoring function prevents other controlling interruptions of the protected field after a period of 30 s following the "readiness" or the last controlling interruption of the protected field. After this 30-second period the start/restart interlocking function is automatically actuated, and the yellow LED lights constantly. By a press of the reset button, the "readiness" for further controlling interruptions may be restored.

This function safeguards against the unintentional and unexpected initiation of a processing cycle after a longer

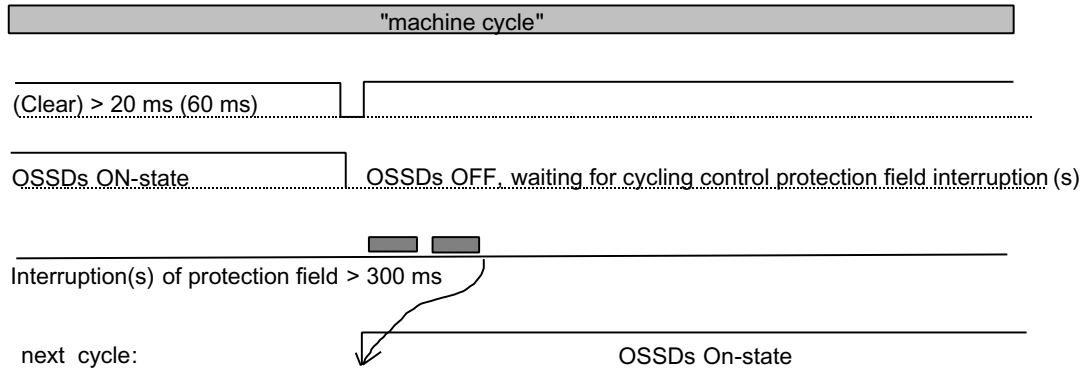
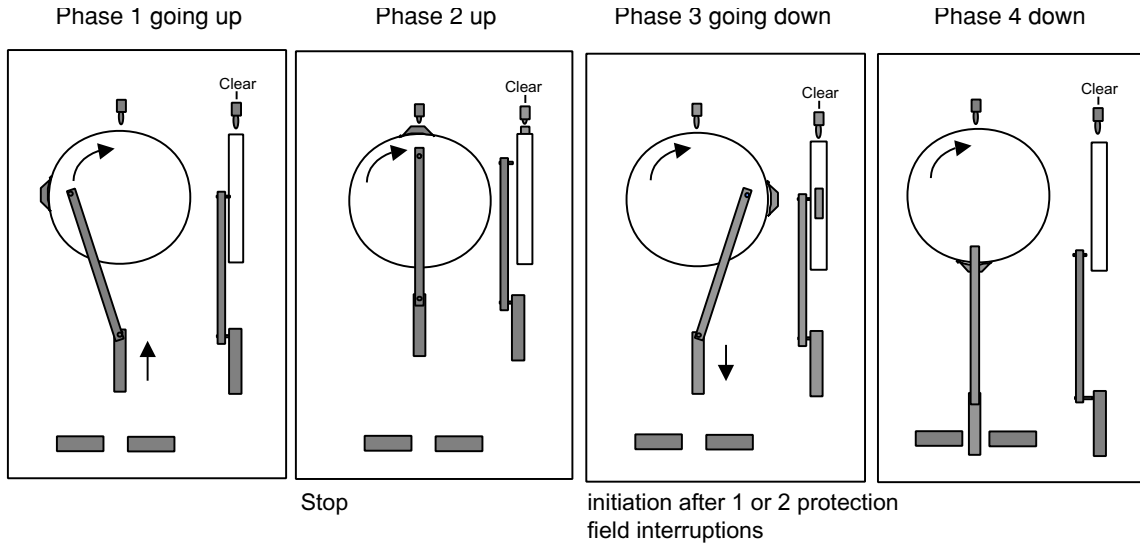
standstill. In justified cases only, and if this does not create any additional danger to the operating personnel, the time monitoring function can be switched to 30 min. by the way of the DIP switch DS1. See Section 3.2.1.

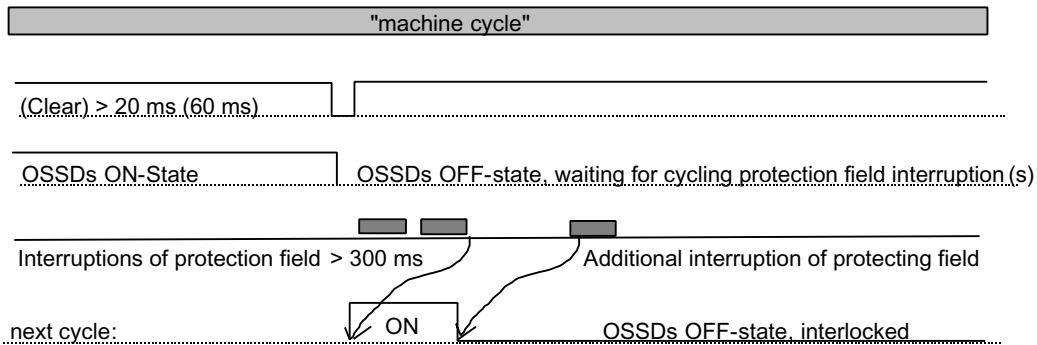
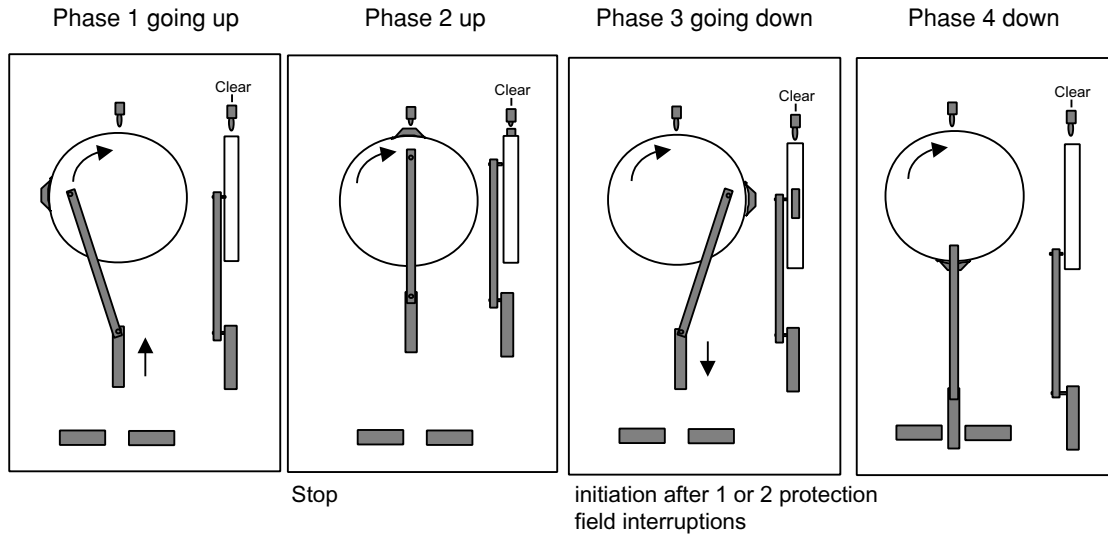
Combination of Cyclical and Muting Operation

When properly installed, MSI-ix provides protection during the entire processing stroke. Sometimes, however, it is important for reasons of safety or operating sequence not to interrupt the production process during certain

phases, such as when a stamp perforates the material. For this reason, Leuze lumiflex offers MSI-mi or MSI mix safety interfaces which combine the cycling and the muting function. In this case, the muting function can be used to deactivate the protective function for the duration of the non-dangerous part of the processing movement. Muting could, for instance, take effect when the stamp has come to within 6 mm of the material and if there is no danger posed by other machine parts during the perforation and return motion of the tool.

3.3.4 Cycling operation, Diagram





Response- and stopping performance times have to be taken in account

3.3.5 Relay Operation Monitoring Function Pre-failure Message in /Rx Versions

For purposes of preventive maintenance, the /Rx output subassemblies are equipped with a function that counts the number of relay operations and issues a pre-failure message. Four different values can be selected at the DIP switches on the subassembly. Before the DIP switches can be set, the Rx subassembly must be completely disconnected from all power sources. It can then be

released from its two holding brackets with a screwdriver and pulled slightly out of the housing.

The table below shows the recommended DIP switch settings with respect to the switching current. Switching voltages of up to 60 V DC and 250 V AC are admissible.

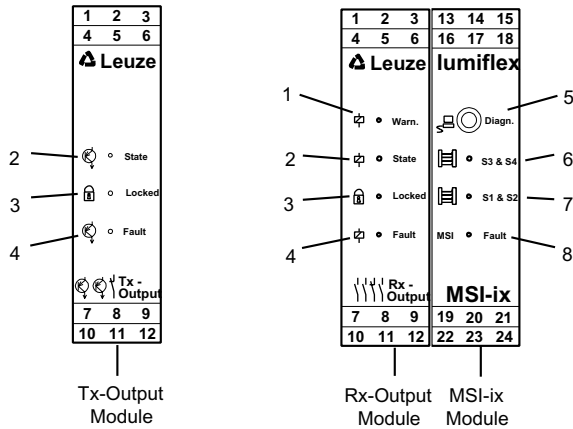
OSSD Switching current (Switching Voltage 60 V DC, 250 V AC max.)	$\leq 0.75 \text{ A}$	$> 0.75 \text{ A}$ $\leq 1.5 \text{ A}$	$> 1.5 \text{ A}$ $\leq 3 \text{ A}$	$> 3 \text{ A}$ $\leq 5 \text{ A}$
Recommended number of Operations	1,000,000 (factory setting)	500,000	200,000	100,000

For setting, see Section 3.2.2.

3.4 Displays

A number of LEDs of various colors indicate the operating status of the MSI modular safety interface. It is also possible to show the LED displays on the PC monitor

using the integrated RS 232 interface and diagnosis connector.



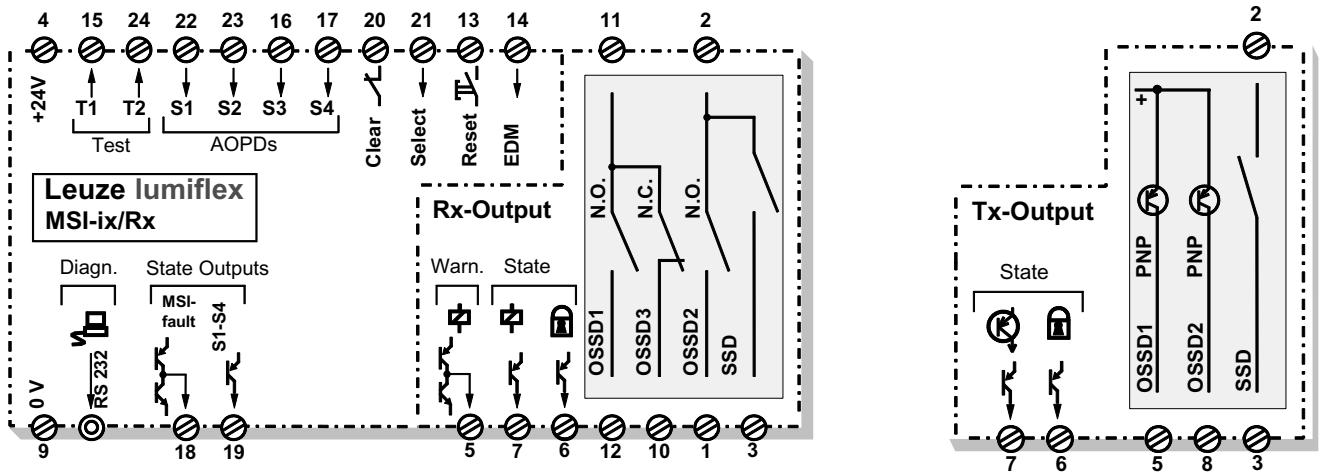
Output /Rx /Tx					
Position	Display/Function	Symbol	Status	LED	Color
1	Preset no. of relay operations (/Rx only)	relay/ Warn	reached not reached	on off	red
2	Safety-related switch output	relay/trans. State	on off	on on	green red
3	Restart interlock – Wait for 2 cycles – Wait for 1 cycle	lock	locked locked locked not locked	on blinks 2x blinks 1x off	yellow yellow yellow
4	Fault in output module	relay/trans. Fault	fault no fault	on off	red

MSI-ix Module					
Position	Display/Function	Symbol	Status	LED	Color
5	Diagnosis, RS 232 See status outputs	jack diagn.	none	none	none
6	Protected field	AOPDs S3 & S4	protected field free not free	on off	green
7	Protected field	AOPDs S1 & S2	protected field free not free	on off	green
8	MSI fault	MSI fault	fault no fault	on off	red

3.5 Status Outputs

Status outputs are not allowed to be used as safety-related signals in release circuits

(see also Section 2. Operating Conditions and Proper Use).



Output /Rx /Tx				
Terminal	Message Function	Symbol	Status	Status Output
5	preset no. of relay operations (/Rx only)	relay	reached not reached	active low active high
6	Restart interlock – Wait for 2 cycles – Wait for 1 cycle	lock	locked locked locked not locked	active high impulse 2 x impulse 1 x active low
7	Safety-related switch status	relay/ transistor	ON OFF	active high active low

MSI-ix Module				
Terminal	Message Function	Symbol	Status	Status Output
Front jack	Diagnosis, RS 232 2.5 mm round connector	–	–	connected to PC with Diagnosis program
18	MSI fault	MSI-fault	no fault fault	active high active low
19	Protected field(s)	S1 - S4	free not (all) free	active high active low

3.6 Diagnosis Function

Requirements for running the diagnosis system: a standard PC or laptop operating under Windows (Version 3.1 or higher) and the MSI software, Version 01, on 3 1/2 " diskette, as well as a serial connection cable and a 2.5 mm jack plug.

- Simultaneous display of all input and output statuses as well as all LED displays on the MSI

With its diagnosis interface, the intelligent modular safety interface MSI offers a convenient way to visualize all of the input and output statuses simultaneously on the monitor.

The connection circuit diagram as well as display fields in different colors can be shown on the screen via the connection terminals. A graphic representation of the MSI front design with the display elements as described in 3.4 also appears on the screen.

Example:

Diagnose-Programm MSI

Prog. version: 0.00

restart-interlock:	without
EDM - mode:	dynamic
EDM:	without
relay prewarming:	100k
relay zyklen:	0k
start test emulation:	no
time monitoring:	without
muting sensor test:	without
muting timeout:	without
muting mode:	Leuze

S1: n.c. S2: n.c. S3: n.c. S4: n.c.

ME1: n.c. ME2: n.c. ME3: n.c. ME4: n.c.

SSI a: n.c. SSI b: n.c. SSI c: n.c. SSI d: n.c.

COM1 Klemmen- und LED-Farben: rot = 0V, grün = 24V, gelb = hochohmig

Start Pronto E-Mail Diagnose-Programm. 09:42

This enables the sequences at individual screw-type terminals to be tracked without the use of additional measuring instruments. The diagnosis function is equip-

ped with on-line help and can be operated in either English or German.

4 Electrical Connection

4.1 Installation Regulations



The general safety precautions in Chapter 2 must be observed. The electrical installation may be performed only if there is no voltage applied, and it must be performed by trained specialists.



In the /Rx versions, it is possible that high voltages may be present at the output contacts. A no-voltage state is achieved only when the 24 V DC supply voltage as well as the supply lines to the switch contacts are safely

4.2 Power Supply Requirements



The supply voltage of 24 V DC must guarantee safe mains separation and be able to bridge an interruption in voltage of 20 ms at full load. The MSI-AC 115 or MSI-AC 230 from Leuze lumiflex have these capabilities up to 0.8 Amps. The ground connection of the MSI is made when it

4.3 Connecting AOPDs, Type 4 or Type 2

The examples below show possibilities for connecting and combining AOPDs of various safety categories and with various output features (relays, safety-oriented semiconductor outputs, cross circuit monitoring within and outside the AOPD).

AOPDs Type 4 with semiconductor outputs and cross connection monitoring function can directly be connected to the safety inputs S1 and S2, respectively to S3 and S4. See Example 1.

switched off and secured against being switched on again.



Coded plug-in terminal blocks allow a connection cross-section of up to 2.5 mm². The supply voltage must be externally fused against excess current with a fuse of 2.5 A. The switch contacts must also be externally fused against excess current with a maximum of 5 A. This prevents the safety-related contacts from welding together if the current load is too high!

snaps up to the metallic, grounded mounting rail by means of the rear clamping device.

The lead for the supply voltage must be externally fused against excess current with a maximum of 2.5 A.

All available safety inputs must be occupied! In case no components are connected, the remaining inputs must be connected to the corresponding test signal using bridges. In doing so, please note that the odd-numbered test signal must be connected to the odd-numbered safety input via the non-delaying bridge (T1 => S1 or S3) and vice versa (T2 => S2 or S4). See Example 2.

AOPDs Type 4 with relay outputs, safety switches or EMERGENCY STOP buttons must be connected so that

the odd-numbered test signal T1 are directed via the non-delaying contacts to an odd-numbered safety input (T1=>S1 or S3) and vice versa (T2=>S2 or S4). See Example 3 and 4.

AOPDs Type 2 are periodically tested using the time-displaced test signals T1 or T2. The odd-numbered test signal must be directed to an even-numbered safety input by the way of the time-delaying AOPD (T1=>S2 or S4)

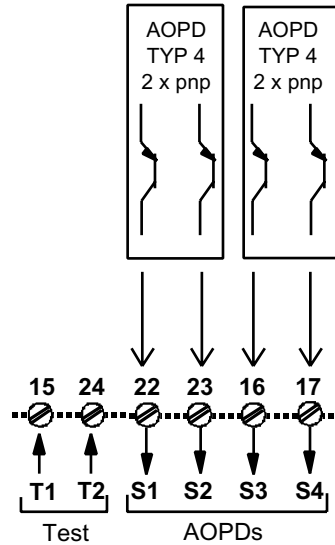
and vice versa (T2=>S1 or S3). The AOPD response time to a test request must be in a range of 2 to 18 ms. See Example 5 and 6.



Using both, the safety inputs S1 & S2 and S3 & S4 separate insulated connector cables must be used to avoid undetected cross connections. Cross connections will be detected between S1 and S2 as well as between S3 and S 4, but not between S1 and S3 or S2 and S4!

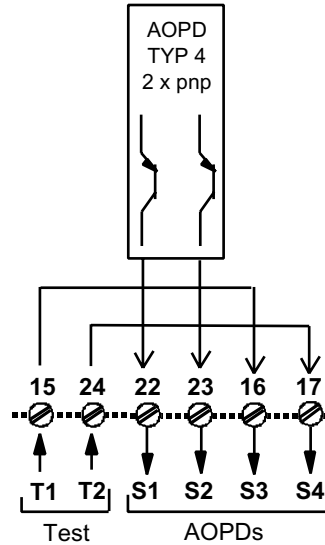
Example 1

2 AOPD Type 4 with 2 safety-related semiconductor outputs and internal cross connection monitoring function each.



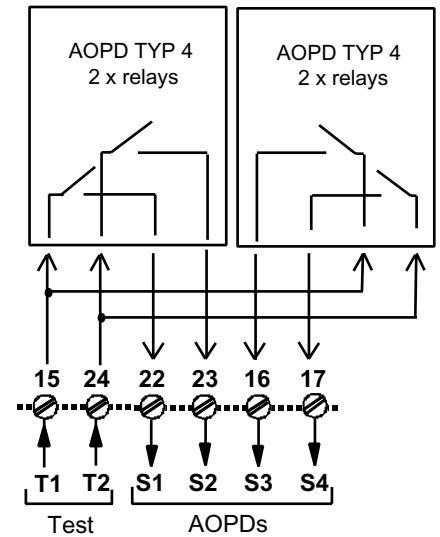
Example 2

1 AOPD Type 4 with 2 safety-related semiconductor outputs and internal cross connection monitoring function.



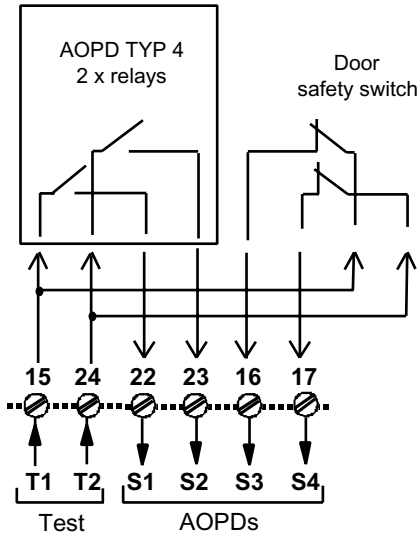
Example 3

2 AOPD Type 4 with 2 normally open contacts each. Separated connection cables to the individual AOPDs are required.



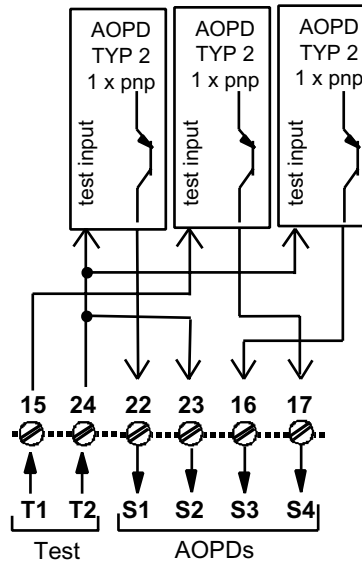
Example 4

1 AOPD Type 4 with 2 normally open contacts and 1 safety switch with 2 normally open contacts. Separated connection cables to the individual safety components are required



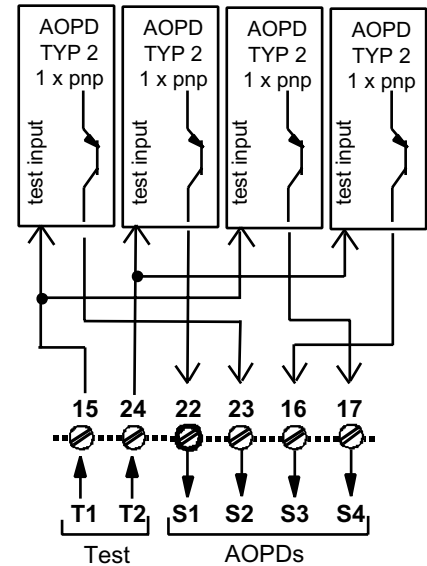
Example 5

3 AOPD Type 2 with 1 safety-related semiconductor output each. Separated connection cables to the individual AOPDs are required.



Example 6

4 AOPD Type 2 with 1 safety-related semiconductor output each. Separated connection cables to the individual AOPDs are required.



4.4 Connecting Machine Controls



The safety-related parts of the controls comprise more than the MSI-ix/Rx or MSI-ix/Tx described above. They also include successive control elements and even power transmission elements which must be safely and promptly shut down. Particular attention must be paid to maintaining the safety category requirements. Important information in this regard can be found in the harmonized European standard EN 954-1.

Essential prerequisites for safe operation are the abilities to electrically influence the interruption of the dangerous movement and to bring the machine to a standstill as quickly as possible. These factors, as well as the response times of AOPDs and the MSI, must be taken into consideration when calculating the safety distance.



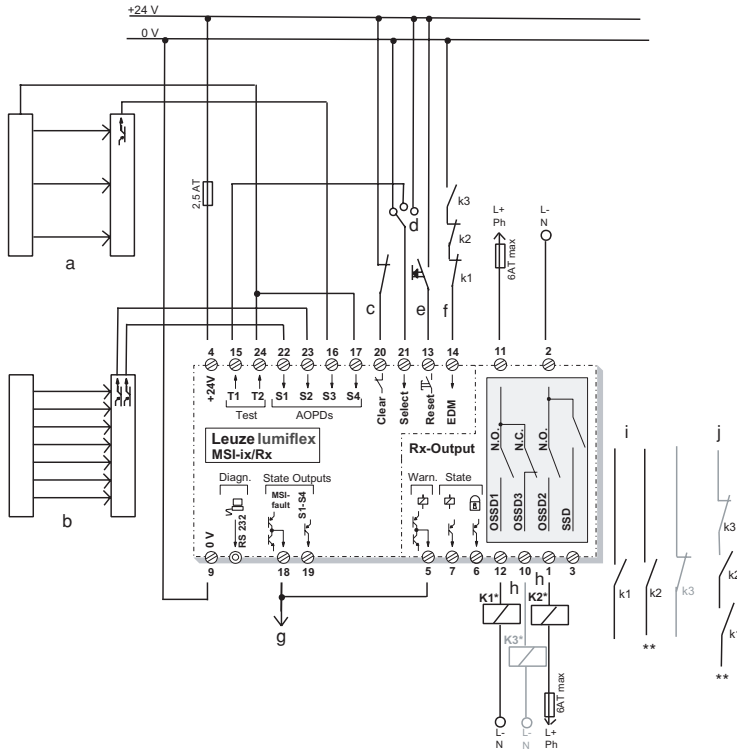
The response times depend on the type of AOPD selected (see Section 6, Technical Data). Other parameters, such as hand/arm/body approach speed or additional safety distance, depend on the particular application and the resolution of the AOPD being used. The European standard EN 999 contains equations and examples for a variety of configurations.

Before starting the next cycle the MSI Safety Interface demands the automatic feedback of the machine cycle. The normal closed contact between +24 V and terminal 20 (Clear) must be interrupted for a minimum duration according to the Technical Data below. This causes all fed-in cycles to be cleared. The output contacts enter the OFF state when the cycle clearance procedure is performed.

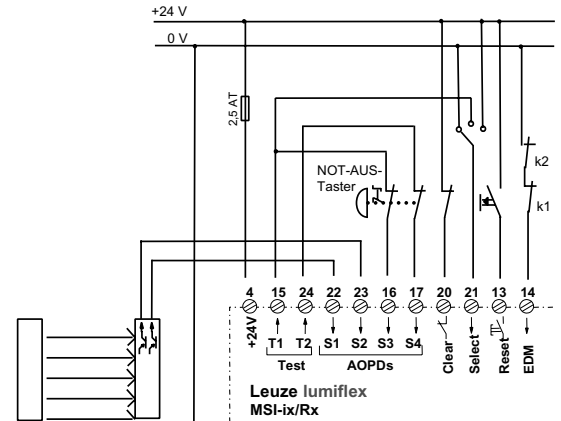
5 Connection Circuit Diagram, Examples

The connection examples below show a wiring suggestion for the MSI-ix/Rx and the MSI-ix/Tx as well as a

connection example for an EMERGENCY STOP button.



Connection example MSI-ix/Rx with one AOPD Type 2 and one AOPD Type 4



Example: connection of two-channel EMERGENCY STOP button

- a = AOPD Type 2 with guarding function
- b = AOPD Type 4 with guarding and control function
- c = Normally closed machine contact for cycle clearance
- d = Operating mode keyed switch (guard only = 0 V, single-break = T1, double-break = 24 V)
- e = Command device for releasing the start/restart interlock
- f = Feedback loop for external device monitoring
- g = Possible collective output for warning/error indications (active low)
- Pin 18 = Indicating output "MSI Fault"
- Pin 19 = Indicating output "sensor status"
- Pin 5 = Warning output "prediction of relay failure"
- Pin 7 = Indicating output "status safety outputs"
- Pin 6 = Indicating output "status start/restart interlock"
- h = Output Signal Switching Devices (OSSDs)
- Pin 3 = Secondary Switching Device (SSD) opens in case of MSI failure
- i = Switching off path with two-channel control
- j = Switching off path with one-channel control
- * = Suitable spark suppression required
- ** = In general, both of the contacts must be used in the subsequent machine control path.
Use relays or contactors with positive-driven contacts only.

All available safety inputs must be occupied!

See Section 4.3.

- a = AOPD Type 4 with guarding and control function
- b = Safety switch (or emergency stop push button)
- c = Normally closed machine contact for cycle clearance
- d = Operating mode keyed switch (guard only = 0 V, single-break = T1, double-break = 24 V)
- e = Command device for releasing the start/restart interlock
- f = Feedback loop for external device monitoring
- Pin 18 = Indicating output "MSI Fault"
- Pin 19 = Indicating output "sensor status"
- Pin 7 = Indicating output "status safety outputs"
- Pin 6 = Indicating output "status start/restart interlock"
- g = Output Signal Switching Devices (OSSDs)
- Pin 3 = Secondary Switching Device (SSD) opens in case of failures
- h = Switching off path with two-channel control
- i = Switching off path with one-channel control
- ** = In general, both of the contacts must be used in the subsequent machine control path.
Use relays or contactors with positive-driven contacts only.

All available safety inputs must be occupied!

See Section 4.3.


6 Technical Data and Ordering Information

6.1 MSI-ix/Rx, MSI-ix/Tx

Version, Type Modular Safety Interface	MSI-ix
Relevant standards, Safety category	TYPE 4 in accordance with EN IEC 61496 T1 see also Section 2, Safety Precautions EN 954-1 (12/96). Category 4 IEC, DIN EN 60204-1 (11/98), Stop 0 DIN V VDE 0801 and A1, Specification Class 6
Connectable safety sensors S1-S4	up to 2 AOPDs, Type 4, Type 3 or up to 4 AOPDs, Type 2 (all in accordance with EN IEC 61496)
Connectable safety switches and command units at S3-S4	Safety switches according to EN 1088 Area Emergency-Stop button according to EN 418
Test outputs T1 and T2, Test interval Test impulses, time-displaced Response time AOPD Type 2 to a test request	200 ms 24 ms each 2 to 18 ms
Available functions	Start/restart interlock External device monitoring Guard only, single break and double break operation
Minimum sensing field interruption for cycling control	300 ms
Control input Start/restart interlock (Reset)	Potential-free normal open contact (button or key button)
Control input External device monitoring (EDM)	Feedback of positive-guided contacts from downstream relays (see con- nection diagram in Section 5)
Control input Operating mode (Select)	Operating mode keyed switch or bridge for permanent operating mode


Control input Cycle clearance (Clear) for AOPDs Type 4 with semiconductor outputs for AOPDs Type 4 with relay outputs for AOPDs Type 2	Normal closed contact to +24 V in the machine cycle, at least 20 ms opening time at least 60 ms opening time at least 60 ms opening time
Status outputs Status protected fields S1- S4	pnp – Semiconductor output All protected fields free active high,+24 V, 60 mA max. not free active low
Safety outputs (Technical Data, see below)	Relay outputs via /Rx-Output Semiconductor outputs via /Tx-Output
Supply voltage	24 V DC, $\pm 20\%$, external power supply with safe mains separation and equalization for 20 ms voltage interruption required, e.g. MSI-AC 115 or MSI-AC 230 0.8 A max. from Leuze lumiflex
Current consumption	approx. 200 mA without external load
External fusing	2.5 A mT
Housing Enclosure rating	IP 20; must be installed in electronics cabinet or housing with an enclosure rating of at least IP 54 Mounting at 35 mm DIN standard rail
Protective class	II
Ambient temperature, Operation	0 ... + 55 °C.
Ambient temperature, Storage	-25 ... + 70 °C
Relative humidity	93 % max.
Connection type	pluggable, coded screw-type terminals up to 2.5 mm ²
Dimensions	See dimensional drawing

6.2 /Rx-Output

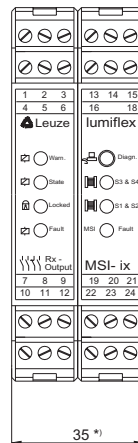
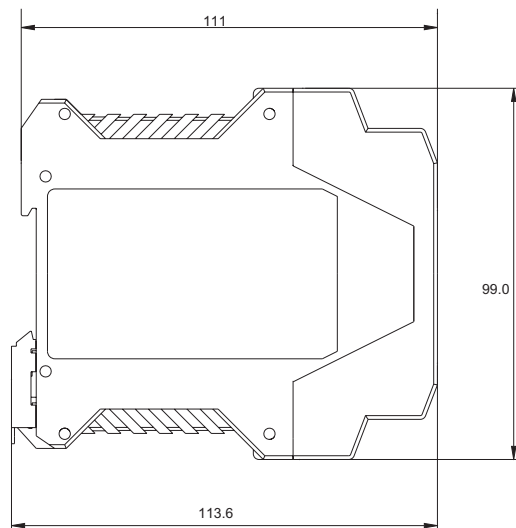
OSSD safety outputs switching voltage/switching current	2 safety-related normal open contacts, 60 V DC, 250 V AC, 5 A max. 1 safety-related normal closed contact, 60 V DC, 250 V AC, 5 A max. Minimum switching current 20 mA			
OSSD external fusing	5 A mT			
OSSD response time MSI (without AOPD)	for AOPD Type 4, semiconductor outputs	18 ms		
		54 ms		
	for AOPD Type 4, relay outputs	54 ms		
	for AOPD Type 2	54 ms		
	for safety switches			
OSSD reset time	100 ms			
OSSD suitable spark extinguishing over the coils of the downstream relays	Required			
SSD secondary switching device (closes after successful start-up test, opens in case of fault) switching voltage/switching current	1 normal open contact, 60 V DC, 250 V AC, 5 A max. / minimum switching current 20 mA			
SSD external fusing	5 A mT			
 Status output "Status switch outputs" not to be used for safety circuit!	pnp switch output			
	OSSDs ON-state:		active high, +24 V, 60 mA max.	
	OSSDs OFF-state:		active low	
Status output "Status start/restart interlock"	pnp switch output			
	OSSD locked:		active high, + 24 V, 60 mA max.	
	OSSD not locked:		active low	
	pnp switch output: wait for 2 cycles			
	OSSD locked:		impulse 2x	
	OSSD not locked:		active low	
OSSD currents over the contacts at 230 V AC switching voltage	≤ 0.75 A	> 0.75 A	> 1.5 A	> 3 A
		≤ 1.5 A	≤ 3 A	≤ 5 A

Recommended limit of operations by way of DIP switch of Rx Module (factory setting 1,000,000)	1,000,000	500,000	200,000	100,000
Status output "Warning – preset no. of operations reached"	Push-pull semiconductor output		Operations not reached: active high, + 24 V 60 mA max.	
	Operations reached:		active low	

6.3 /Tx-Output

OSSD safety outputs switching voltage/switching current	2 safety-related pnp semiconductor outputs with cross connection monitoring 24 V DC, 300 mA max.		
OSSD response time MSI (without AOPD)	for AOPD Type 4, semiconductor output	8 ms	
	for AOPD Type 4, relay output	44 ms	
	for AOPD Type 2	44 ms	
	for safety switches	44 ms	
OSSD reset time	100 ms		
SSD secondary switching device (closes after successful start-up test, opens in case of fault) switching voltage/switching current	1 normal open contact, 60 V DC, 250 V AC, 5 A max. / minimum switching current 20 mA		
SSD external fusing	5 A mT		
 Status output "Status switch outputs" not to be used for safety circuit!	pnp switch output		
	OSSDs ON-state:		active high, +24 V, 60 mA max.
	OSSDs OFF-state:		active low
Status output "Status start/restart interlock"	pnp switch output: guard only		
	OSSD locked:		active high, + 24 V, 60 mA max.
	OSSD not locked:		active low
	pnp switch output: wait for 2 cycles		
	OSSD locked:		impulse 2x
	OSSD not locked:		active low
	pnp switch output: wait for 1 cycles		
	OSSD locked:		impulse 1x
	OSSD not locked:		active low

6.4 Dimensional Drawing



*) Stringing together without distance possible

6.5 Ordering Information

Typ	Part No.
MSI-ix/Rx	549903
MSI-ix/Tx	549923
MSI-AC 115 (power supply 24V DC, 0.8 A)	549940
MSI-AC 230 (power supply 24V DC, 0.8 A)	549908

MSI diagnosis software	549930
PC cable 3 m	549953
PC cable 5 m	549955
/Rx output subassembly (replacement part)	509211
/Tx output subassembly (replacement part)	509201

